Preservice Teachers' Observations of Children's Learning During Family Math Night

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Abstract

Family math night can easily be implemented into mathematics methodology courses providing an opportunity for field-based learning. Preservice teachers were asked to develop and implement an inquiry-based activity at a family math night event held at a local school with personnel, elementary children and their parents in attendance. This action research examines what preservice teachers discovered about how children learn mathematics during their interactions with parents and children. Preservice teachers' individual reflections focusing on children's learning were qualitatively analyzed and clustered. In addition, data from teacher educator's observation notes was used to triangulate findings. Four themes were identified in relation to children's needs for promoting learning in mathematics: (1) activity adjustment (2) engagement through guiding and questioning (3) motivational issues and (4) the use of manipulatives and visuals. The event appeared to offer preservice teachers insight into the elements of activities needed to guide children's learning in mathematics.

It makes sense that preservice teachers would learn best through interactions with children out in the field (Cady, Meier & Lubinski, 2006; Gallego, 2001; Moyer & Husman, 2000). While out in the field, preservice teachers can experience what it means to guide children to understand concepts; it is realistic learning. These authentic experiences have the potential to increase engagement (Kozar & Marcketti, 2008) and allow preservice teachers to experience what it means to teach rather than just reading about how to teach. It is important to interconnect field-based experiences with coursework by providing opportunities to interact and learn with children (Gallego, 2001; Putnam & Borko, 2000).

A study by Pringle (2006) showed that preservice teachers have positive dispositions toward the integration of students in their assignments, and recognize the importance of students' alternative conceptions in using such knowledge to make decisions about teaching. Moyer and Husman (2006) evaluated teachers who were enrolled in a mathematics methodology course on an elementary school campus versus those who were not. They found that those who were able to learn with children better understood the connection coursework had on student learning and understanding in mathematics. In a long-term study, Linek, Fleener, Fazio, Raine and Klakamp (2003) found that when children were present in mathematics methodology courses, preservice teachers were better able to understand learning. Their study showed that the collaborative effort of integrating the course resulted in heightened awareness including better performance from both teachers and students.

In the university setting, curriculum and experiences can be regulated by the professors. However, controlling the environment that preservice teachers experience during their student teaching placements can be very difficult; this experience is sometimes detached from the methodology course. Preservice teachers do not connect what is taught in their methodology courses with what is experienced in the field when contents are experienced as separate entities (Putnam & Borko, 2000). There is a sense of disconnect with the university curriculum, and preservice teachers focus on attaining good grades rather than understanding how the content of the course relates to students' mathematical understanding and learning (Moyer & Husman, 2006).Preservice teachers should be able to experience and appreciate what it means for a child to understand mathematics through interactions based on a synthesis of university curriculum and field-based learning.

To encourage the documented benefits of learning with children, family math night was integrated into a mathematics methodology course. The preservice teachers designed and implemented an activity to be carried out at a university organized family math night event at a local elementary school. The activities were inquiry-based in nature and focused on either primary (K-3) or intermediate (4-6) elementary grades. The goal of this study was to examine what preservice teachers discovered about elementary children's learning in mathematics. Specifically, the research question was: What kind of insight did the preservice teachers develop in relation to how children learn mathematics through the creation and implementation of an inquiry-based family math night activity?

Family Math Night

Family math night is an exemplar of collaboration linking a higher education institution, local community and elementary schools. Preservice teachers create an activity or game to be implemented at a local school (Freiberg (2004) and Kurz (2011). Children and their parents attend the event and circulate to various activities set up as stations in a multi-purpose room. The preservice teachers model and provide a structured, parent-friendly lesson plan to guide the implementation of the activity at home.

There are several frameworks guiding the integration of family math night in mathematics methodology courses. Freiberg (2004) describes a program of integrating family math fun night with preservice teachers. Within this program, there are various types of activities including drill and practice, problem solving, estimation and others. Additionally, Freiberg describes the coordination of these events, provides a framework to guide future implementation and describes many of the observed benefits. Lachance (2007) has a model where the students worked with a partner to develop an activity to help children and their parents learn using hands-on explorations.

The integration of family math night varied from Freiberg's (2004) and Lachance's (2007) described frameworks. Preservice teachers were required to create an inquiry-based learning activity and they completed the assignment on an individual basis supported by several elements to guide the investigation (Kurz, 2011). In general, the preservice teachers created an investigation supported by standards, including an objective and a list of materials needed. They core of the family math night investigation framework included the activity description, guiding

questions and modifications. After the event, the preservice teachers wrote a guided reflection focusing on children's thinking.

Methodology

Research methods

The study documented what happened during the family math nights arranged as a part of the mathematics methodology course and investigated what preservice teachers and the teacher educator noticed during the experience. Following an action research tradition, the researchers used constant comparative method (Bogdan & Biklen, 2006) to gain insights into strong points and deficiencies of the family math night activity in order to make revisions in its implementation over time.

Participants

The preservice teachers were enrolled in a mandatory upper division mathematics methodology course for perspective teachers at a culturally diverse university in the western United States. Fifty preservice elementary teachers participated in the study; 84% were female. They were at various stages of their program of study: 8 were interns (teaching without a credential), 1 was full-day student teaching, 25 were half day student teaching, and 16 were not in the classroom. Due to the large number of participating preservice teachers, three schools were selected to host a family math night on different evenings of the same week. The preservice teachers chose what school they wanted to attend based on their needs. They all participated in one evening of family math night after developing mathematical activities. The teacher educator regularly visited the family math night activities, stayed throughout the entire event, and took comprehensive notes. She also queried both children and the preservice teachers throughout the event focusing on the mathematics of the activities.

Data Sources

Discussions and investigations demonstrating the kinds of mathematical activities appropriate for two hour family math events took place in their mathematics methodology course. Preservice teachers were provided with books to peruse in class to help guide their investigations into appropriate inquiry-based activities for primary and intermediate elementary students (Coates & Stenmark, 1997; Thompson & Mayfield-Ingram, 1998). Since most of the elementary schools were Title I with a significant amount students who were Latino/a, the preservice teachers with the resources were encouraged to translate their activity into Spanish.

The activities developed for the event were designed as inquiry-based investigations. The preservice teachers had to create an inquiry based objective supported by standards. Steps to help prepare for the activity needed to be provided. The foundational components of the assignment included these features: describing the inquiry-based activity, providing open-ended questions to support the investigation, and creating modifications to alter the activity making it less challenging and more challenging as needed (Kurz, 2011).

In order to change how preservice teachers evaluate their understanding of education, reflections should take place (Pryor & Kuhn, 2004; Tillema, 2000). According to Davis (2006), writing provides the opportunity to connect ideas about learners with their instruction. Potari and Georgiadou-Kabouridis (2009) showed that reflection is an important element used to investigate the understanding and development of an elementary teacher in the teaching of mathematics. With the importance of reflection in mind, preservice teachers were asked to complete a written reflection focusing on one question: What did you learn about how children learn mathematics from your family math night experience? The reflections were designed to provide a minimal amount of structure, allowing the preservice teachers to interpret children's learning in relation to mathematics. The reflection was due one week from the event.

While preservice teachers' reflections were the primary source of data, teacher educator's activity observation notes and other anecdotes were used to supplement and triangulate the themes that emerged in preservice teachers' narrative texts. In addition, the family math night activities written by the preservice teachers were also used to support the analysis. This process contributed to the understanding of the Family math night activity and preservice teachers' insights. Using multiple perspectives (preservice teachers, teacher educator) and having two researchers do thematic coding of the preservice teachers' narrative texts also triangulates the data increasing the validity of the findings (Miles & Huberman, 1994).

Data Analysis

The preservice teachers' narrative texts were evaluated looking for similarities and differences to identify common themes that were qualitatively stated (Ryan & Bernard, 2003). The constant comparative method (Glaser, 1965; Bogdan & Biklen, 2006) was used to discover the themes. This method allowed the researcher to evaluate the text looking for parallels and variations between the participants' statements. The narrative texts were continually compared and contrasted, and themes were developed (LeCompte, 2000). In addition, the themes were regularly reevaluated and revised throughout the evaluation process. Teacher educator's observation notes and other anecdotes were coded by two researchers in light of their relationships to the themes which appeared in narrative text. The review of the literature and previous study results did not impact the derived themes; they themes were solely discovered through analysis of the narrative text and observation notes. Since these narratives were taken word for word from the participants, it allowed an effective discovery of themes (Ryan & Bernard, 2003).

The experience was examined and defined through reflections of the participants based on their experiences during family math night. The hermeneutic phenomenological approach asked preservice teachers to describe what is was like for them to learn from students rather than to ask them what they believe was important to take into consideration when participating in some type of educational practice (van Manen, 1997). This philosophy guided our investigation toward the needs of preservice teachers and their perceptions of student learning with the aim of better understanding the impact of educational practices.

LeCompte (2000) has provided steps for analyzing qualitative data and these steps were followed for this study. First the data were prepared for evaluation through the organization of the

narrative texts. During this step, the research question relating to the kind of insight that preservice teachers developed in relation to how children learn mathematics through the creation and implementation of an inquiry-based family math night activity was reviewed. The second step involved the *declaration* of significant items concerning the themes of educational insight. This involved repeated readings of the data in search of significant themes. For the third stage, themes were organized and put into categories though comparing and contrasting items. Items that were similar were clustered together. After this clustering, the taxonomies were identified. Step four concerned creating patterns through questioning and analyzing the patterns that were present. The final step entailed describing the patterns as meaningful structures (see LeCompte (2000) for detailed steps).

Results

Through the analysis of the reflections completed by the preservice teachers after the event, themes indicated that the preservice teachers were contemplating how the family math night experience influenced their understanding of student learning. The four themes were:

- The adjustment, modification, and adaptation of activities are needed to help promote learning.
- To facilitate learning and engagement, teachers have to guide using higher level questioning techniques and focus on investigating mathematical ideas through promoting thinking.
- There are several issues in relation to student motivation in learning mathematics including: encouraging problem solving, discovery techniques and rewards (external and internal).
- The use of manipulatives and visuals support mathematical learning by allowing students to develop and show their ideas.

Activity Adjustment

One of the themes was the need to adjust the investigations to meet student needs and the realization that students are at various levels of mathematical understanding. One preservice teacher stated "I learned a lot about modifying games at family math night…Not all students are at the same level and we have to modify lesson plans." The importance of learning how to modify and adjust activities to assist the students was a common element. "The levels of mathematic ability did not depend on what grade the student was in. I was surprised to how much of a gap appeared between the students." Another stated, "Just like in a classroom each student 'caught on' with varying speeds and had to be given the guidelines in different forms." Specifically, a preservice teacher stated:

> For the second graders who had difficulties, I modified the activity and allowed them to use one die instead of two. Using one die allowed students to make combinations of a one-digit number… they began to understand the activity and after a few tries of using one die, I had them try using two dice.

While another stated, "I think that all lessons and activities need to have modifications or possible modifications to make for students who are performing at levels above or below what the lesson or activity is designed for."

The teacher educator commented on the preservice teachers initial difficulties with the activity adjustment. As various children visited each activity, the preservice teachers became more and more effective at meeting the students' needs. Because there was a constant flow of children, the preservice teachers were able to test and then perfect their adjustments.

Engagement through Guiding and Questioning

The preservice teachers described their experiences in questioning students relating to their design of the activity. One stated, "I learned that you have to be patient and explain just enough to them so that they could get the concept and answers on their own." One preservice teacher created an activity with fractions using dominos. He stated:

> When I would ask him some of the leading questions for the game, like 'How could you score more points on an individual play?' he glanced at the tiles already played and thought for a moment and answered that I should play tiles with the lowest denominator.

Another thought, "Some of the children need little coaching beyond a guiding question occasionally. Most of them were able to think through difficult spots and come to solutions." While another commented,

> When I noticed students struggling, I used the guided questions from my lesson plan to assist them…once they got past wanting to use an already set equation in their mind and began playing with the tiles to make many new equations, the students enjoyed the game.

Because the guided questions were written in advance, the preservice teachers had already prepared to question the children at a deeper level. As the teacher educator circulated, she noticed the preservice teachers looking at their activity instructions to remember their questions. They used the questions when they did not know what to say to the students in terms of enriching the activity. They also used these questions to engage in mathematical discussions.

Motivation

Different issues relating to student motivation in mathematics were noticed and by the participants. "I was a bit surprised to see these children having so much fun playing math games." Rewards were discussed and evaluated. Some of the preservice teachers commented on the need of rewards such as prizes, color, and competition to motivate children to learn in mathematics. "They did not want to play the game for the fun of playing the game, but for whatever prize I might have for them." Another affirmed, "Some students were more interested in getting the sticker or the [play] dollar than the game." Others saw external rewards as distractions. One stated, "I would really recommend that for the next family math night you do not allow prizes…so that math is the main focus." Some preservice teachers perceived rewards as unnecessary to teach mathematics, believing that properly designed mathematical activities

alone will motivate children to learn. "I was a little surprised that they found my activity as interesting as they did especially since I did not have anything to give out." And another said, "It was amazing to see the concentration on the children's faces and their joy for doing math for the pure fun of it. No reward other than accomplishment was necessary"

In terms of motivation, the teacher educator commented on the overall excitement of the participants in completing the activities. Initially, the children were drawn to the activities with prizes; the prizes seemed to get the event started. Then, the children began to play at all activities. The children would stay at the activities they enjoyed, not necessarily the activities with rewards. The motivation was related to the children's mathematical interest (either naturally occurring or encouraged by the preservice teacher efforts to help children learn).

Manipulatives and Visual Aids

The use of manipulatives and visuals to enhance the understanding of mathematics was observed by the participants. "While watching students' various techniques for adding numbers, it became obvious that students often need visual aids in order to connect mathematical processes with some form of tangible example." Another commented, "If I had told the students to find multiple factors for a number and not given them manipulatives I don't think they would have been able to see how the number breaks up in their head." The preservice teachers commented on the benefit of structuring more hands-on, inquiry-based type activities with manipulatives and appeared to learn from using this approach. A preservice teacher who had students make their own clocks to use as a manipulative commented:

> When [students] are required to create their own manipulative, they have a deeper awareness of the parts that go on it. This in turn, allows them a more conceptual view of what the parts represent and helps them to acquire a more thorough understanding of how to use the manipulative when they begin to experiment.

The teacher educator noted that the manipulatives helped the preservice teachers demonstrate their mathematical activities in a conceptual manner. They used the manipulatives to help the children understand the mathematics in a richer, deeper manner. The tools supported the activity and helped both preservice teachers and children represent and explain their mathematical thoughts and ideas.

Discussion

The preservice teachers discovered some important aspects of children's learning in mathematics by creating and modeling a family math night activity and these aspects were supported in the teacher educator's activity observation notes. The activity paired with a reflection can help the preservice teachers become more mathematically aware of children's needs in understanding mathematics. Warfield, Wood and Lehman (2005) support this idea saying that it is crucial that preservice teachers learn to reflect on students' mathematics learning and about their role in the development of students' thinking. The four themes indicate that insight took place regarding some of the ways in which children learn and understand mathematics.

It is important to note that the activity structure surely influenced the preservice teachers' discoveries. The components of the assignment aligned with the observations described by the preservice teachers. For example, open-ended questions are included in the assignment and are encouraged to be used to assist teaching during the family math activity. Preservice teachers then commented on the need to use open-ended questions to facilitate children's learning in mathematics. Cobb (1988, p. 92) noticed that "teacher actions do influence problems that students attempt to solve and thus the knowledge they construct." The way the structure aligned with the observations showed that preservice teachers were implementing inquiry-based learning in the appropriate manner and were able to see how the structure supports children's mathematical learning.

The preservice teachers observed the diversity of learning levels and styles among children, both across grade levels and among children of the same grade. These interactions allowed the preservice teachers to experience the diversity they will experience in the classroom. In Wang and Cai's (2007) study, mathematics teachers view an effective teacher as a facilitator who is sensitive to a child's social and cognitive needs. With this experience came the insight that investigations must be adjusted and adapted to meet the varied needs of students. As Ball (2000) pointed out, part of quality teaching in mathematics includes making modifications based on what the students need to better understand the task at hand.

The need to facilitate engagement through the use of higher level questioning while also promoting children's thinking was observed by the participants. Authentic tasks that require children to justify their mathematical reasoning are generally considered valuable (Ball, 1993). Children should be in charge of their own learning while adults facilitate their investigations and explorations learning along with them (Gallego, 2001). To support the investigations, questions that require students to explain and justify their thinking can support learning. In a study by Leikin and Rota (2006), discussion and deep questions with elaborate answers are a valuable component when designing and implementing inquiry-based investigations. Sahin and Kulm (2008) found that sixth grade teachers focusing on mathematics rarely asked guiding questions and instead focused on probing and factual questions. Inquiry-based learning should be supported by the use of deeper questions, providing children with the opportunity to justify and explain their mathematical reasoning (Leiken & Rota, 2006; Sahin & Kulm, 2008). In this study, the participants saw value in deep questions; they focused on the justification of mathematical ideas through open-ended questions.

Similar to other relevant studies (Moyer & Husman, 2006; Rule & Arthur, 2007), preservice teachers in their reflections noticed the importance of student motivation in mathematics. According to the preservice teachers' narratives and teacher educator's observations in this study, it is difficult to unambiguously describe motivation. There was no consensus on what elements are necessary to motivate children to learn in mathematics. They did observe that motivation is an important building block in relation to children's learning in mathematics and there are a variety of factors relating to motivation. This relates to Middleton and Spanias (1999) findings. They describe a variety of theoretical orientations toward motivation in mathematics, concluding with some key observations that some of the preservice teachers in this study also observed. For example, investigations need to be structured at an appropriate level of challenge and difficulty for students. The actions of the teachers can greatly influence student motivation.

On the subject of intrinsic versus extrinsic motivation, Middleton and Spanias found that intrinsic motivation is superior to extrinsic motivation in mathematics. Some of the preservice teachers alluded to this in their reflections. As well, Middleton and Spanias pointed out that instructional design can be highly motivating in mathematics. Hickey, Moore and Pellegrino (2001) also found that when children are presented with investigations that mirror reform-based ideas, children are more likely to be motivated. The preservice teachers' observations showed that they were beginning to develop a sense of the importance of structuring inquiry-based learning to yield more motivated students.

The preservice teachers viewed visual aids and manipulatives as valuable resources. The use of manipulatives to teach mathematics is recommended as they help students concretely develop ideas and relationships (Skemp, 1987). Many of the preservice teachers incorporated the use of manipulatives. They noticed the value of manipulatives to help children form and explain ideas. Moyer (2001) found that manipulatives are frequently used to make mathematics fun, and often used as a diversion rather than to support mathematical development. As Moyer pointed out, simply using manipulatives is not enough; use should be based on sound ideas including how the manipulatives relate and connect to mathematics. The family math night event allowed the preservice teachers to see the value of manipulatives as tools to rationalize and develop thinking, as was indicated by their reflections.

This study also offers supportive evidence on the benefits of field-based learning. As Kozar and Marcketti (2008) pointed out, field-based learning offers preservice teachers valuable experiences promoting understanding. Linek et al. (2003) found that collaborative efforts in local elementary schools that included field-based components improved how teachers teach. Whereas the benefits of learning while interacting with children have been well documented, this study supports the advantages of field-based learning specific to family math night. The design and implementation of family math activities promote insight regarding how children learn, although long-term benefits were not evaluated.

Conclusion

Potari and Georgiadou-Kabouridis (2009) describe the journey of an elementary teacher over time, with key elements that include reflecting, designing activities, and using research and practice to influence thought. With the framework of this event, preservice teachers were able to design, implement and reflect on mathematical activities as practiced. They were able to connect their event experiences with how children learn and understand mathematics. It is a start to guiding preservice teachers to become reflective learners while designing activities for the purpose of having children experience mathematical ideas through hands-on, inquiry-based activities.

The preservice teachers' ability to recognize and reflect on students' needs in learning mathematics while participating in a family math night is just a beginning. Swars, Smith, Smith and Hart (2009) found that over time, prospective elementary teachers were able to change their beliefs when participating in mathematics curriculum focusing on cognitively guided instruction. In their study, changes took place over a two year period; the prospective teachers' beliefs continued to evolve throughout the program. Fennema, Carpenter, Franke, Levi, Jacobs and

Empson (1996) also found that teachers were able to change their instruction to better meet their students' needs over a four-year period with instruction and guidance focusing on the integration of cognitively guided instruction.

Huffman, Thomas and Lawrenz (2008) found that preservice teachers who were prepared focusing on reform-based methodology were only slightly more likely to use reform-based practices as compared to those who were not given this kind of instruction. It is important to realize the results for this study are temporary if they are not strengthened with other experiences. As Grootenboer (2008) has noted, changes in beliefs about teaching are complex and take place over long periods of time, with preservice teachers often resistant to change. For depth to take place, preservice teachers' learning experiences must be supported through other experiences that encourage inquiry-based learning both in the university setting and during the first few years of teaching. Family math night can be one element of this journey.

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